APPENDIX C

A Review of Aquatic Life Conditions
Draft Technical Memorandum
Lower Boise River

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DRAFT Technical Memorandum

Lower Boise River

Prepared for
State of Idaho

by
Idaho Division of Environmental Quality, Boise Regional Office
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Introduction

The following technical review evaluates water quality conditions with respect to the aquatic life beneficial uses in the four water quality limited (WQL) stream segments in the lower Boise River (Table 1). Aquatic life beneficial uses encompass aquatic organisms, including fish, that live or reproduce within the river and some of its tributaries. The watershed is defined as U.S. Geological Survey (USGS) hydrologic cataloging unit 17050114 and extends from Lucky Peak Dam to the mouth of the Boise River. Those stream segments that are water quality limited and have been found to be impaired for one or more beneficial uses will require the development of an appropriate total maximum daily load (TMDL) allocation. Stream segments that have conditions exceeding aquatic life criteria, but are not listed as WQL, should also be addressed when developing pollution control strategies for the watershed.

This document describes physical and chemical water quality conditions in the Boise River. The status and distribution of aquatic communities, such as fish and aquatic insects, are also described to evaluate water quality conditions, habitat conditions, and beneficial use status. The Division of Environmental Quality (DEQ) evaluates impairment in streams using applicable criteria (from designated and existing uses) and alternate measures of aquatic life status. Alternate measures include the presence of fish, available habitat, flow conditions and aquatic insects. The combined physical, chemical, and biological indicators are used to develop management recommendations, including TMDLs where needed.

Table 1. October, 1996 list of water quality limited segments in the lower Boise River.

Name	Boundaries	Listed Pollutants	Priority
Boise River	Lucky Peak Dam to Barber Diversion	Flow Alteration	low
Boise River	Barber Diversion to Star	Sediment, Dissolved Oxygen, Oil & Grease	low
Boise River	Star to Notus	Nutrients, Sediment, Dissolved Oxygen, Temperature, Bacteria	HIGH
Boise River	Notus to Snake River	Nutrients, Sediment, Dissolved Oxygen, Pathogens, Temperature	HIGH

Condition of Aquatic Life Communities

DEQ is in the process of developing a standardized approach for evaluating the status of beneficial uses on large rivers at the reconnaissance level. A standard approach is not available at this time and the TMDL schedule for the lower Boise River requires use of other methods for evaluating aquatic life beneficial uses. A substantial amount of data is available for the Boise River that allows for evaluation of the status of uses based on the condition of aquatic life communities and water quality conditions in relation to appropriate water quality criteria. The condition of aquatic life communities in the Boise River has been evaluated by looking at both the benthic macroinvertebrate and fish populations in the River.

Description of Fish Populations

Fish in the Boise River are an important part of the river system, as well as a significant recreational resource. Much of the information available about the status and distribution of fish in the Boise River and its tributaries comes from the Idaho Department of Fish and Game (IDFG). The professional opinions of the IDFG with respect to the distribution of fish and status of cold water biota, warm water biota and salmonid spawning in the lower Boise River are included in Appendix D.

Brown Trout, Rainbow Trout, and Mountain Whitefish are the dominant cold water game fish in the upper part of the River. Most of the trout found in the reach above Star Diversion are hatchery fish but wild trout are present. IDFG has documented limited natural reproduction of wild trout occurring in the Boise River or its tributaries in this part of the river. Trout are essentially absent downstream of the Star Diversion. Sculpin, another cold water fish, are found in the river from Lucky Peak to the Lander Street area. Mountain Whitefish are found in the rest of the river, to the confluence with the Snake.

Gibson (1975) sampled fish in the Boise River in the winter, summer and fall of 1974. He found a similar pattern, trout in the reach above Star and Mountain Whitefish along the entire length of the river. Gibson's catch rate for Mountain Whitefish was significantly higher in the fall and winter than in the summer.

The USGS sampled fish in the Boise River in December 1996 and August 1997. Mountain Whitefish were found in all reaches of the River in both sampling events, although their frequency decreased significantly at the mouth (W. Mullins, USGS, written commun., 1997). Mountain Whitefish appear to be reproducing along the entire river, based on the presence of juvenile and adult fish at each sampling location. Warm water species such as Largemouth Bass, Smallmouth Bass and Channel Catfish were found from Middleton to the mouth of the River.

Status of Fish Populations

At DEQ's request, the IDFG evaluated the status of cold water biota (CWB), warm water biota (WWB) and salmonid spawning (SS) along the length of the Boise River (Appendix D). A summary of IDFG's opinions is shown in Table 2. IDFG considers cold water biota to be impaired in all segments of the River. Salmonid spawning is impaired from Diversion Dam to Notus. IDFG believes that Mountain Whitefish spawning in the reach from Notus to the Snake River is likely, but the available information is insufficient to determine the status of the salmonid spawning use based on fish data alone.

Table 2. Status of fish populations in the lower Boise River.

Segment	Designated Uses	Existing Uses	Impaired Uses	Causes of Impairment
Boise River Lucky Peak Dam to Barber Park	CWB, SS	CWB, SS Trout, Mountain Whitefish	CWB, SS	Flow, lack of cover, sediment, toxins, lack of gravel, channelization, temperature armored substrate
Boise River Barber Park to Veterans Park	CWB, SS	CWB, SS Trout, Mountain Whitefish	CWB, SS	SAME as ABOVE
Boise River Veterans Park to Star	CWB, SS	CWB, SS Trout, Mountain Whitefish	CWB, SS	SAME as ABOVE, plus flood control, gravel mining, unscreened diversions, barriers, low flow
Boise River Star to Caldwell	CWB, SS	CWB, SS Trout, Mountain Whitefish	CWB, SS	SAME as ABOVE
Boise River Caldwell to Snake River	CWB	CWB, WWB, SS Mountain Whitefish (Seasonal)	CWB	SAME as ABOVE but temperature and sediment more significant

Description of Aquatic Insect Populations

Aquatic insects, known as benthic macroinvertebrates, serve as important consumers of organic material in streams, as well as food sources for fish. Insect populations are very useful indicators of the overall health of streams. When insects are diverse and abundant, streams are in good health. Small numbers of insects, lack of diversity, and dominance by pollution tolerant insects are indicative of streams that are degraded.

The benthic macroinvertebrate data collected by the USGS in the Boise River span five sites from Lucky Peak to the confluence with the Snake River. The data were collected on two sampling dates, in October of 1995 and October of 1996. A technical memorandum interpreting the data is included as Appendix E. DEQ collected three sets of benthic macroinvertebrate samples on August 18, 1995 in the Boise river near Star, Caldwell, and Notus. A more detailed review of the dominant and pollution tolerant species helps to further characterize the overall quality of the Boise River.

Organisms that are tolerant of degraded conditions generally increase from Lucky Peak toward the mouth of the Boise River, with the highest proportion of tolerant taxa generally found in the Middleton and Caldwell area.. For example, *Tricorythodes minutus*, a mayfly that is highly tolerant of degraded conditions, is only about two tenths of one percent of the total population at Barber Park, but represents 42 percent of the insect population at the mouth of the river. Tolerant mayflies in high percentages, such as the *Tricorythodes*, indicate nutrient enriched streams with high summer water temperatures (Wisseman, 1996). In similar fashion, pollution tolerant midges increase from roughly 5 percent of the population at Barber Park to about 26 percent of the population near Caldwell. Scrapers, insects that consume algae attached to hard surfaces, represent about five percent of the population at Barber Park, and about seven percent at Glenwood Bridge. Near Middleton and Caldwell, both the abundance of scrapers and the percentage of the total population represented by scrapers decline (about 2 percent and less than one percent, respectively), indicating degraded conditions (Wisseman, 1996).

Organisms that favor good conditions decline in numbers toward the mouth of the Boise River. Stoneflies, characteristic of good water quality and clean gravel substrates, are present in very small numbers at Barber Park and Glenwood Bridge. Stoneflies are completely absent in the reach of the river from Middleton to the Snake. Moderately tolerant caddisflies fluctuate as a percentage of the total population from Barber Park to Middleton, but decline significantly downstream of Middleton. Another moderately tolerant organism, *Baetis tricaudatus* (a mayfly), represents twenty percent of the total insect population at Barber Park, and 17 percent of the population at Glenwood Bridge. *Baetis tricaudatus* drops to about six percent of the total population at Middleton, and drops again to about 1.3 percent at Caldwell. Near the mouth of the Boise River, *Baetis tricaudatus* increases to 8.5 percent of the total population. The decline of the mayfly indicates that conditions at Middleton and Caldwell are degraded relative to Barber Park and Glenwood Bridge.

Naididae, worms tolerant of fine sediment, increase measurably from Glenwood Bridge (7.3% of the population) to Caldwell (17%). Similarly, *Plecoptera*, organisms intolerant of fine sediment and warm temperatures, are few to zero at Middleton and Caldwell. W. Mullins (USGS, personal commun., 1997) has suggested that changes in benthic macroinvertebrates along the River indicate altered substrate may be a significant cause impairment. Altered substrate is a common result of excess sediment.

Evaluation of Applicable Water Quality Criteria

Pollutants of Concern

A variety of pollutants may impair aquatic life beneficial uses when present in significant quantities or concentrations. Pollutants of concern include sediment, nutrients (nitrogen and phosphorus), dissolved gasses, temperature, and toxic materials such as chlorine, metals, or organic chemicals. Some impairments of aquatic life are due to factors not normally considered to be "pollutants." Gravels for spawning, cover elements for trout, recreational fishing pressure, channelization, flow regulation, and the loss of tributary spawning areas can also limit the abundance and health of fish populations.

Sediment

Sediments are suspended when water velocities are high enough to carry solids along with the flow of the stream. When sediments are suspended in flowing water, the light available for aquatic life is limited. Fish that feed by sight may have difficulty finding prey, or may avoid streams that are extremely turbid. At concentrations of about 50 to 100 mg/l for periods of 30 to 60 days sublethal and lethal affects on salmonid reproduction are observable (Newcombe and Jensen, 1996). At extremely high concentrations, suspended sediments may interfere with the function of fish gills. In areas where currents are normally slow, or during low water conditions, sediments fall out of suspension and settle on the stream bed.

Solids may remain on the stream bed until the spring when flows increase, or may remain for years. Sediments can cause impairment by settling and altering habitat, and by carrying nutrients such as phosphorus. Attached phosphorus may serve as a reservoir of nutrients that can later be released into the water. On the stream bed, sediments (especially sand size and smaller particles) can limit the oxygen available to fish eggs, and can increase the mortality of emerging embryos. In addition, excessive fine sediments may limit the growth and movement of aquatic insects that are an important part of the food web in streams.

Nutrients

Within this document, the term nutrients refers to all the species of nitrogen and phosphorus. Phosphorus can enter a stream either as dissolved ortho-phosphate in the water or bound to sediment particles. Once in a stream, dissolved phosphorus may be transported along with the river flow, may be utilized by plants or algae, or may adsorb to solids in the water. Sediment attached phosphorus is likely to remain bound to solids, and is likely to be released only at a very slow rate. Thus, significant quantities of phosphorus may move slowly downstream in conjunction with sediment movement.

Nitrogen is highly soluble in water and moves easily through surface runoff or ground water to enter streams. In stream, nitrate is the most stable and readily transported form of nitrogen. Ammonia that enters well oxygenated streams like the Boise River is very quickly oxidized to become nitrate. Ammonia in small concentrations can be assimilated by streams. However, if ammonia enters a stream in high concentrations, it can have a toxic impact on fish and other aquatic life.

Organic sources of nitrogen often hydrolyze quickly to ammonia, and then in turn to nitrate. As nitrogen moves with a stream, its various forms may be utilized for growth by algae or plants. Nitrogen may also leave the water as dinitrogen gas where sufficient organic carbon and facultative bacteria are present in the stream bed. Unlike phosphorus, nitrogen is probably not stored for any significant length of time in sediments.

When nitrogen and phosphorus are combined in slow moving, warm waters with plenty of available light, algal blooms may occur. When algae die, decay of organic matter may reduce dissolved oxygen (DO) to levels that adversely affect fish. Very low DO levels can cause fish kills. The growth of algae is most significant when both nitrogen and phosphorus are present in solution in high concentrations. Either nitrogen or phosphorus may be a "trigger", or limiting factor on algal growth, making growth more likely when high concentrations of dissolved phosphorus and nitrogen are present.

Dissolved Gasses

Dissolved gasses, such as oxygen and nitrogen, are essential to aquatic life, but can be harmful if present in excessive concentrations. When dissolved gasses become super-saturated at greater than 110% of the normal saturation for a given water temperature, fish may be harmed. The primary risk for fish is caused by dissolved nitrogen, a problem caused primarily by large spillways at dam sites. Gasses enter the water through equilibrium with the atmosphere, aeration by features such as dams and riffles, or by the release of oxygen from photosynthesis. Supersaturation may often dissipate quickly downstream of some sources, or may persist for hours in areas where plants and algae are growing.

Very low DO, less than 6.0 mg/l for cold water biota, can also be a problem, because fish and other aquatic organisms will be stressed. High water temperature or inputs of oxygen consuming wastes can cause DO concentrations to decrease. Excessive quantities of algae can consume oxygen when they die and decompose.

Temperature

The temperature of the water in streams can impact fish and other aquatic life. As the temperature goes up, the water holds less oxygen. In addition, many species of fish are best adapted to a particular range of temperatures. If temperatures are too high for a period of time, fish are placed in stress. At higher than optimal temperatures, the growth rates of juvenile fish may be reduced, the success of feeding declines, and fish may be more susceptible to predation.

pH

The pH of a stream describes whether the water is acid, neutral, or basic. Fish and other aquatic organisms are generally adapted to survive within a limited range of acid or basic waters. An acidic or basic condition in a stream may persist until some type of natural buffering becomes available.

Metals and Toxic Substances

Metals and toxic substances are a concern for aquatic life in two respects. First, such materials may cause direct harm to fish and other aquatic organisms through either acute or chronic affects. Second, since the Boise River is a significant recreational fishery, materials that can accumulate in tissues of fish that may be eaten are a significant concern for human health. The applicable criteria are designed to protect aquatic life directly and to protect human health for the consumption of organisms.

Applicable Water Quality Criteria

The State of Idaho Water Quality Standards and Waste Water Treatment Requirements establish a set of criteria designed to protect aquatic life in streams, lakes, and reservoirs. The numeric and narrative criteria that apply to the lower Boise River are summarized below.

Numeric Criteria

The criteria listed in Table 5 below are summarized from a complete description in the State of Idaho Water Quality Standards and Wastewater Treatment Requirements, IDAPA 16.01.02 250.02.

Table 3. Summary of aquatic life numeric water quality criteria.

Criteria	Cold Water Biota	Salmonid Spawning*
pH	6.5 - 9.5	6.5 - 9.5
Total Dissolved Gas	≤ 110 % of saturation	≤ 110 % of saturation
Residual Chlorine	1 hour average ≤ 19 μg/l 4 day average ≤ 11 μg/l	1 hour average ≤ 19 μg/l 4 day average ≤ 11 μg/l
Metals and Toxic Substances	Set of limits described in IDAPA 16.01.02.250.07	Set of limits described in IDAPA 16.01.02.250.07
Dissolved Oxygen	≥ 6.0 mg/l	Water Column: greater of: ≥ 6.0 mg/l or 75% of saturation** or 90%of saturation*** Intergravel: 1 day minimum ≥ 5.0 mg/l 7 day average ≥ 6.0 mg/l
Temperature	Daily Maximum ≤ 22° C Max. Daily Avg.≤ 19° C	Daily Maximum ≤ 13° C Max. Daily Avg.≤ 9° C
Ammonia	Not to exceed one hour and four day averages calculated according to IDAPA 16.01.02 250.02.c.iii	Not to exceed one hour and four day averages calculated according to IDAPA 16.01.02 250.02.c.iii
Turbidity	Below any applicable mixing zone: 1) Shall not exceed background by more than 50 NTU instantaneously 2) Shall not exceed background by more than 25 NTU for more than 10 consecutive days	Below any applicable mixing zone: 1) Shall not exceed background by more than 50 NTU instantaneously 2) Shall not exceed background by more than 25 NTU for more than 10 consecutive days

*Applicable only during the time period listed for given species in IDAPA 16.01.02.250.02.d.iv; Rainbow Trout, January 15 to July 15; Mountain Whitefish, October 15 to March 15.
**IDAPA 16.01.02.278 - Site specific criterion for Boise River from Veteran's State Park to mouth.
***General aquatic life criterion that applies to Boise River from Lucky Peak Dam to Veterans State Park.

Narrative Criteria

In addition to numeric criteria, the following narrative criteria were evaluated to identify possible impairment of aquatic life uses in the Boise River.

Toxic Substances

Surface waters of the state shall be free from toxic substances in concentrations that impair designated beneficial uses. These substances do not include suspended sediment produced as a result of nonpoint source activity (IDAPA 16.01.02.200.02).

Excess Nutrients

Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses (IDAPA 16.01.02.200.06).

Sediment

Sediment shall not exceed quantities specified in Section 250., or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350.02.b (IDAPA 16.01.02.200.08).

Description of Criteria Exceedences

The lower Boise River exhibits few significant exceedences of aquatic life criteria, with the exception of temperature and sediment. From Lucky Peak to the mouth of the Boise River, pH, dissolved oxygen, chlorine, and ammonia meet the requirements listed in the table above, and do not impair aquatic life. Temperatures exceed the state criteria for cold water biota and salmonid spawning frequently.

Sediment

Sediment impairs aquatic life beneficial uses throughout the river, from Lucky Peak Dam to the confluence with the Snake River. Near the City of Boise, flow regulation by Lucky Peak, Diversion Dam, and Barber Diversion creates significant accumulations of sand that damage fish habitat behind each dam. As the sand washes downstream, it contributes to high levels of embeddedness in the stream bed from Diversion Dam to Star, limiting the spawning of trout and whitefish. Downstream of the Star Road diversion, sediment load from agricultural drains increases significantly. Sands continue to contribute to high levels of embeddedness, the proportion of fine sediment in the substrate increases and the concentration of suspended sediments in the water column increases. Increased turbidity has often been noted in the Boise River downstream of Middleton.

The condition of benthic macroinvertebrates also indicates that sediment is a significant cause of impairment, particularly in the River below Middleton. The presence and abundance of species requiring clean substrate decreases and species that are more tolerant of sediment increase.

Sediment Impacts on Substrate

In general, the portion of the Boise River near the city has an armored substrate that consists primarily of large cobbles. Of the cobbles, pebbles, and gravel present, more than 60 percent were embedded in the 25 to 49 percent range during a 1987 survey (Asbridge and Bjorn, 1988). Embeddedness exceeding 32 percent is generally considered to indicate impaired habitat. Most pea gravels in Loggers Creek were also embedded in the 25 to 49 percent range during the same study, limiting the value of the substrate for salmonid spawning. Cover elements for salmonids are also in short supply, with over 70 percent of the areas studied by Asbridge and Bjorn (1988) having only depth as a source of cover for fish.

More recently, the USGS has measured embeddedness and substrate particle size at Eckart Road and near Middleton in November 1997 (W. Mullins, USGS, written commun., 1997). Ocular embeddedness estimates at Eckart Road ranged from 2 (50 - 75% embedded) in a deep run to 4 (25 - 50% embedded) in riffles. All embeddedness observations at the site near Middleton were rated as 1 (≥ 75%) or 2. Pebble count data from the same sites indicate a much higher proportion of sand and silt (about 48% compared to about 18%) near Middleton than at Eckart Road. Gravels were found at both sites, although the proportions were greater at Middleton than Eckart Road. The substrate at Eckart Road is dominated by cobbles, very coarse gravels and sand.

Suspended Sediment

Sediment suspended in the water column can adversely affect aquatic life. Many fish species are adapted to high suspended sediment levels for short durations that commonly occur during natural spring runoff events. However longer durations of exposure can interfere with feeding behavior, damage gills, reduce available food, reduce growth rates, smother eggs and fry in the substrate, damage habitat and induce mortality. Eggs, fry and juveniles are particularly sensitive to suspended sediment, although at high enough concentrations adult fish are affected as well. Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on suspended sediments in streams and estuaries. For Rainbow Trout, lethal effects, which include reduced growth rate, begin to be observed at concentrations of 50 to 100 mg/l when those concentrations are maintained for 20 to 60 days. Similar effects are observed for Brown Trout at 100 mg/l suspended sediment for a duration of 30 - 60 days and for Largemouth Bass at 63 mg/l for 30 days. Adverse effects on habitat, especially spawning and rearing habitat were noted at similar concentrations. In an earlier report, Newcombe and MacDonald (1991) observed that benthic macroinvertebrate populations were significantly reduced and sensitive species eliminated at similar concentrations when duration ranged from 30 to 100 days.

From 1994 through 1997, when the USGS sampled the four main river stations, suspended sediment concentrations in the lower Boise River occasionally exceed 50 mg/l at Glenwood

Bridge (4 out of 29 measurements) and Middleton (1 out of 22 measurements) and more frequently at Parma (10 out of 26 measurements). Concentrations ranged as high as 245 mg/l at Parma. Highest concentrations are generally observed during spring runoff, although 245 mg/l of suspended sediment was measured at Parma on July 19, 1995 and concentrations exceeding 50 mg/l have been observed in every month from February to August. The data is insufficient to determine the duration of high suspended sediment concentrations.

Lack of Spawning Gravels

IDFG has identified lack of spawning gravels as a significant cause of impairment of cold water biota in the Boise River. Rainbow and Brown Trout, in particular, need clean gravels for spawning. The presence of the dams in the upper part of the River has severely limited recruitment of new gravels. The potential spawning gravels that are in place are both embedded and are frequently dry during low flow conditions.

Nutrients and Nuisance Aquatic Growth

Algae of various types grow in the water and on the bed of the Boise River. Algae provide a food source for many aquatic insects, which in turn serve as food for fish. Algae grow where sufficient nutrients (nitrogen, phosphorus) are available to support growth. Flows, temperatures, and sunlight penetration into the water all must combine with nutrient availability to produce optimum conditions for photosynthetic growth. When nutrients exceed the quantities needed to support primary productivity, algae blooms may develop. Algae blooms can adversely impact aquatic life. Death and decomposition of algae creates an oxygen demand. If the demand is high enough, DO levels in the water body may decline to low levels that harm fish.

Nutrients in the Boise River are significantly enriched (Figures 1 and 2). Under the right conditions, algae blooms are possible. Total phosphorus concentrations in samples collected by the USGS range from well below the EPA recommended criterion for flowing waters of 0.1 mg/l at Diversion Dam to as high as 0.8 mg/l at Middleton and 0.5 mg/l at Parma. The highest concentrations occur during low flow conditions, which are generally in the winter when aquatic plant growth is less of a concern. However, total phosphorus concentrations during the growing season at Middleton and Parma are more than sufficient to support algae growth.

Ortho-phosphate concentrations follow a similar pattern to total phosphorus with respect to flow conditions and location. Highest concentrations are during low flow periods, concentrations increase downstream, and ortho-phosphate is more than adequate to support nuisance aquatic growth under the right conditions. Bothwell (1988, 1989) and Horner, Welch and Veenstra (1983) have shown that phosphorus concentrations as low as 25 to 50μg/l are sufficient to support growth of periphyton communities. Generally, ortho-phosphate concentrations are 75 to 80 percent of total phosphorus concentrations in the Boise River (Table 6).

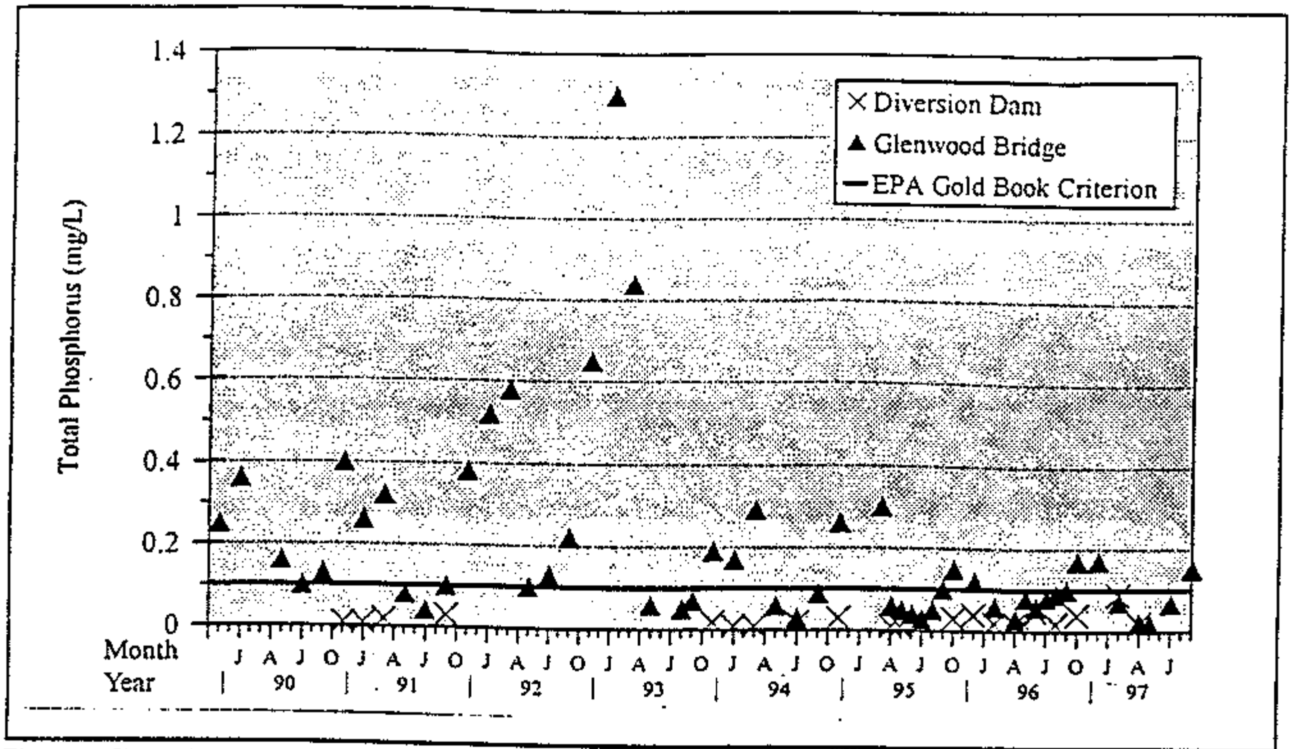

Figure 1. Total phosphorus concentrations on the lower Boise River Diversion Dam and Glenwood Bridge.

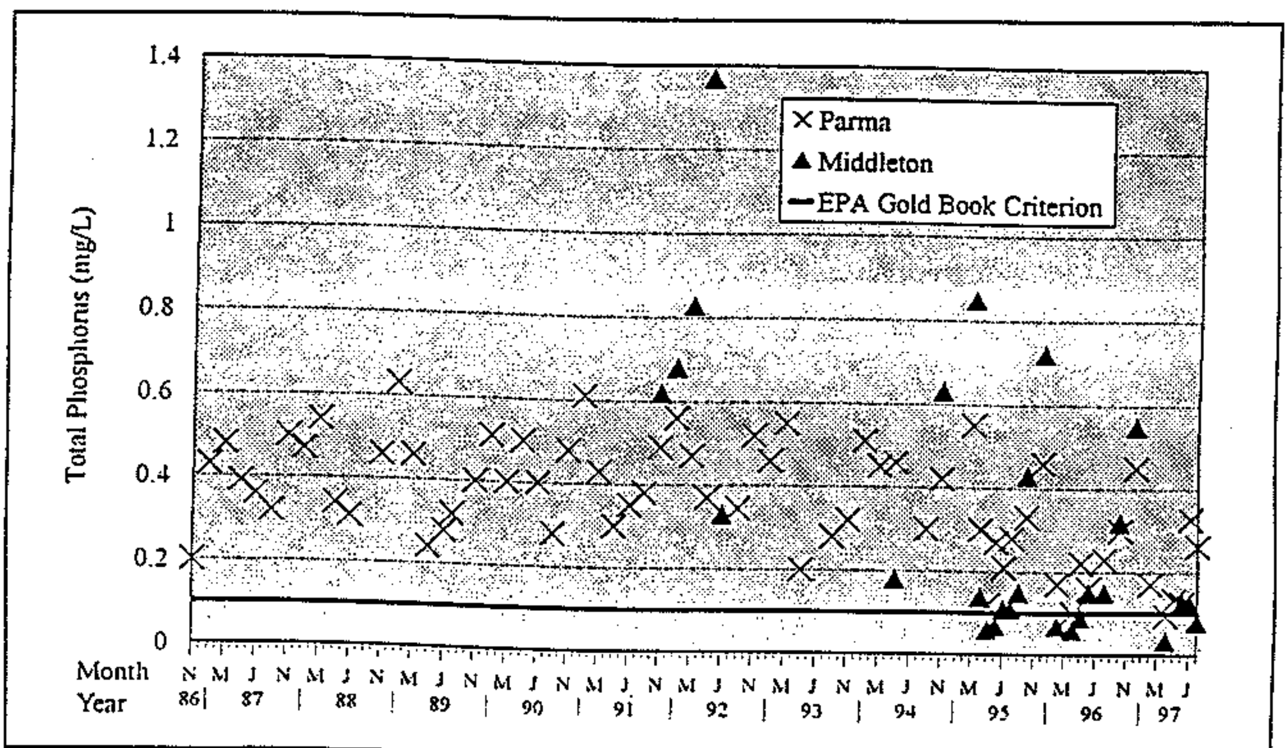

Figure 2. Total Phosphorus Concentrations in the Boise River near Middleton and Parma.

Table 4. Average percent of total phosphorus that is ortho-phosphate in the Boise River based on USGS synoptic data.

Station	Percent Ortho Phosphate/Total Phosphorus
Diversion Dam	73
Glenwood Bridge	78
Middleton	81
Parma	77

Chlorophyll-a in algae in the water column and in the algae attached to rock (periphyton) are commonly used to measure algal productivity. The USGS measured chlorophyll-a in the water column in the Boise River at Diversion Dam, Glenwood Bridge, Middleton, and Parma ten times in 1995 and 1996 (Figures 3 and 4). None of the measured values exceed 20 μg/l. Idaho does not have a numeric criterion for chlorophyll-a. Oregon's criterion is 15 μg/l. An exceedence of the Oregon criterion triggers a determination whether a beneficial use is adversely impacted. North Carolina has a chlorophyll-a criterion of 40 μg/l. Comparing the USGS data to these criteria, and considering that the USGS has not measured single exceedence of the DO criteria for aquatic life DEQ has concluded that nutrients are not causing excessive growth of water column algae.

Chlorophyll-a data from periphytic algae do not provide for an equally clear conclusion. Periphyton grow on pebbles and cobbles along the stream bed. In streams that are not impacted by an over abundance of nutrients, the periphytic algae grow as single celled organisms called diatoms that are kept in check by the grazing of aquatic insects. When nutrient availability exceeds the basic needs of diatoms, other species, including bulky, filamentous algae such as *Cladophora* may grow on the stream bed. The bulky filamentous algae can cause significant aesthetic and water quality impairments.

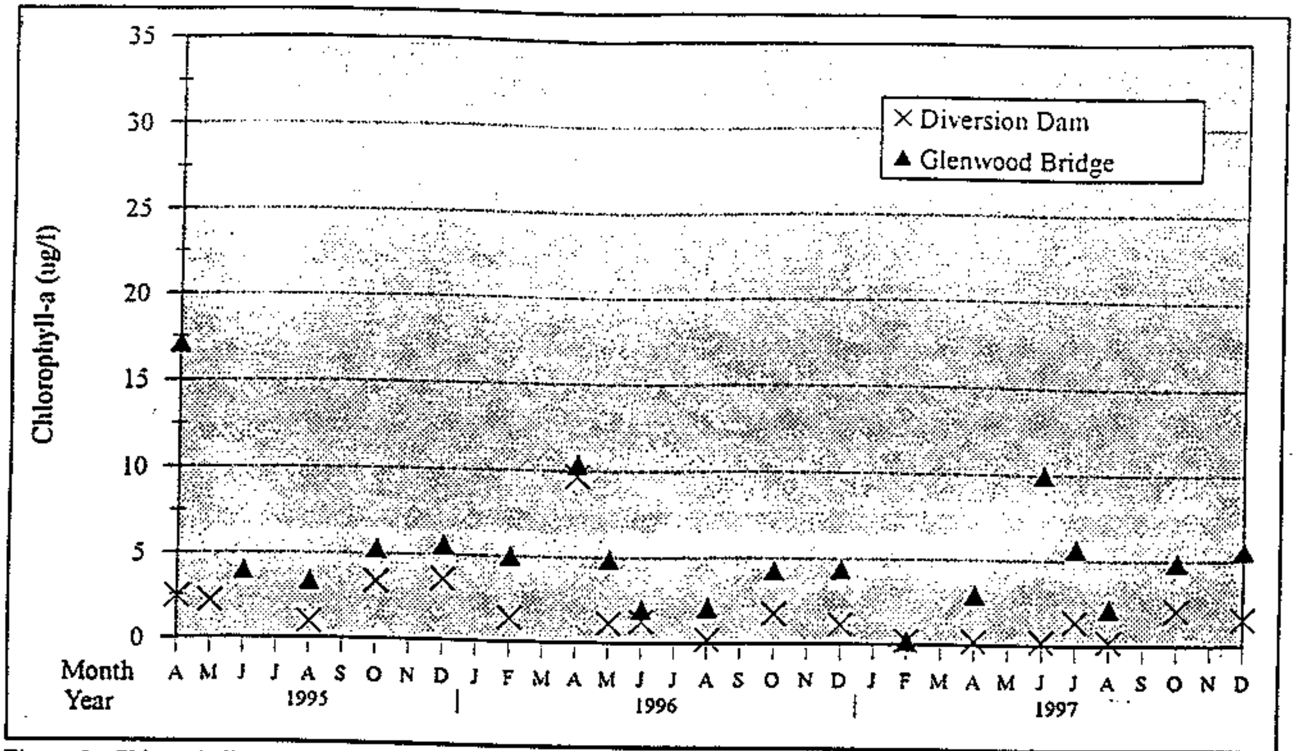

Figure 3. Chlorophyll-a concentrations in the lower Boise River at Diversion Dam and Glenwood Bridge.

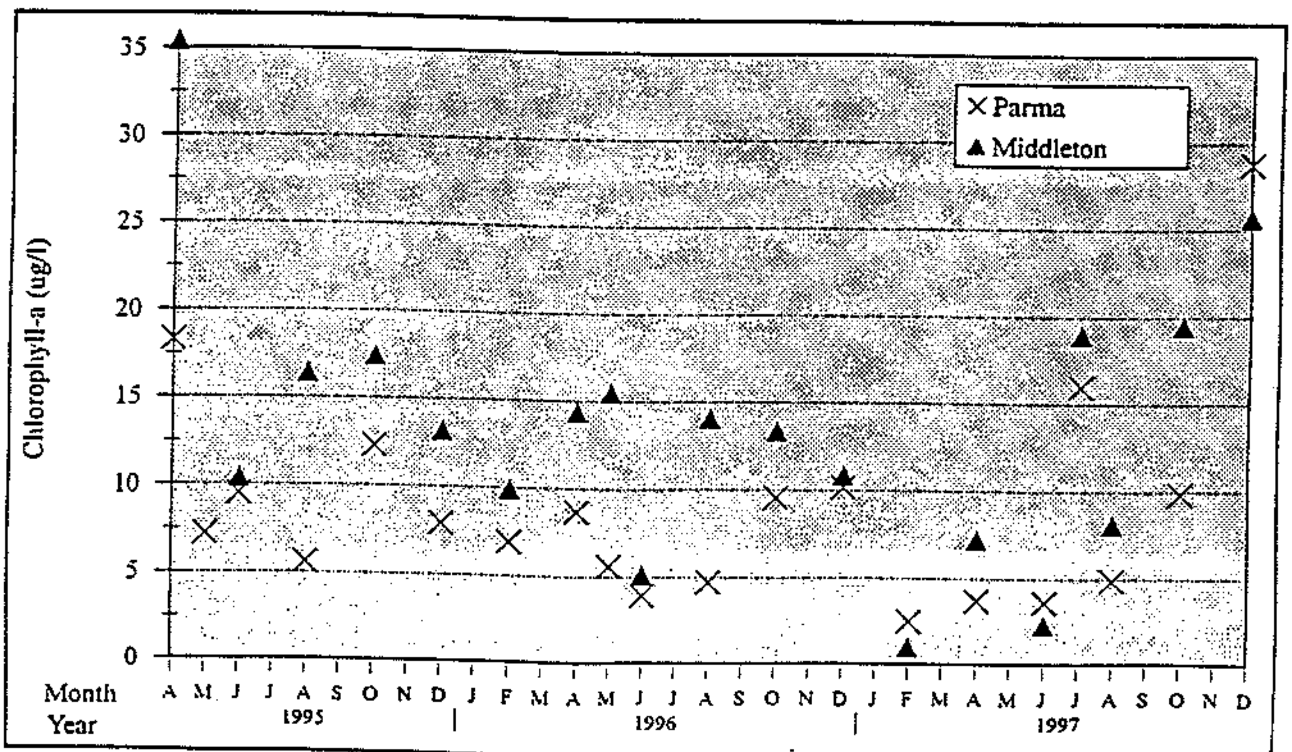

Figure 4. Chlorophyll-a concentrations in the Boise River near Middleton and Parma.

DEQ does not have numeric criterion for periphytic chlorophyll-a. Several authors have suggested that periphyton chlorophyll-a values from 100-200 mg/m2 constitutes a nuisance threshold, above which aesthetics are impaired (Horner and others, 1983, Watson and Gestring, 1996; Welch, Horner and Patmont, 1989; Welch, Jacoby, Horner and Seeley, 1988). However, no thresholds have been proposed for adverse impacts to aquatic life. Impacts to aquatic life would generally be identified based on DO problems.

The USGS collected periphyton samples in the Boise River at Eckert Road, Glenwood Bridge, Middleton, Caldwell and the mouth in October of 1995 and 1996. Chlorophyll-a in periphyton ranges from a low of .025 mg/m2 at Eckert Road to a high of 933 mg/m^2 at Caldwell (Figure 5). The highest values are consistently found at Middleton and Caldwell, where diversions result in lower flows and water temperatures begin to increase.

While periphyton chlorophyll-a values exceed suggested nuisance thresholds in these segments, the absence of DO problems indicates that nutrients were not causing impairment of aquatic life in the Boise River during the sampling periods. However, the high nutrient concentrations and low flow conditions in the Middleton and Caldwell reaches suggests that in drought years, if flows are low enough, conditions in the River could support sufficient algae growth to impair aquatic life. This possibility is supported by the presence of masses of filamentous algae and rooted aquatic macrophytes in canals in the Boise River valley. When the enriched river water is diverted into unshaded, low gradient canals with slower flow velocities, algae and rooted aquatic macrophytes grow freely.

It is also possible that high sediment concentrations in the River below Caldwell are preventing algae growth by limiting the amount of light that penetrates the water column. If sediment concentrations in the summer are reduced, algae growth in the reach of the River below Caldwell may increase.

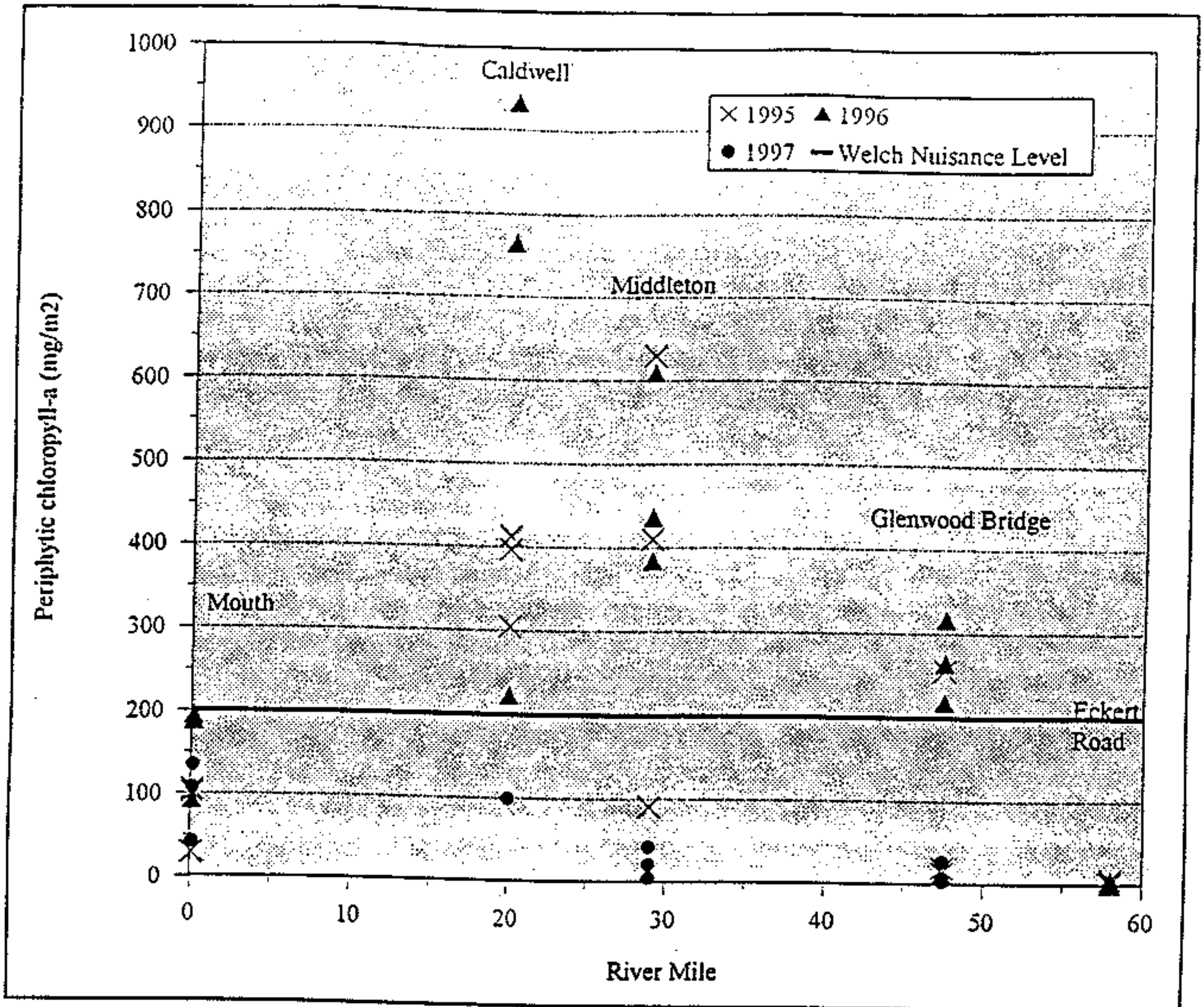

Figure 5. Periphytic chlorophyll-a in the lower Boise River.

Dissolved Gasses

The USGS measured DO in the Boise River at four sites. Start dates for sampling range from November 1992 at Glenwood Bridge and Parma through May 1994 at Middleton. DEQ has evaluated data through August 1997 at each of the four sites. During this period, no DO concentrations were measured that were lower than the applicable criteria. The data that were collected are limited to dissolved oxygen, and thus are insufficient to evaluate the percent saturation for total dissolved gasses.

Temperature

A complete review of water temperatures in the lower Boise River with respect to existing cold water biota and salmonid spawning criteria is available in Appendix F. The following section summarizes the important conclusions regarding water temperatures in the Boise River.

Cold Water Biota Criteria

The daily maximum (22 ° C) and maximum daily average (19° C) criteria for cold water biota are occasionally exceeded at Middleton. Upstream of Middleton, water temperature have not exceeded the two criteria in the available data. The frequency of water temperatures in excess of cold water biota criteria increases at Caldwell and increases more at Parma. USGS data from Parma show water temperatures in the river exceeded both the daily maximum and daily average criteria for cold water biota every July and August from 1987 to 1997 (except for 1995, for which no data are available). Temperatures in the 23 to 25° C range are not uncommon at Parma during July and August. In hot, dry years temperature criteria may be exceeded for virtually all of the days in July and August.

Salmonid Spawning Criteria

The daily maximum (13 ° C) criterion associated with salmonid spawning is exceeded in the Boise River from Diversion Dam to Middleton. The salmonid spawning criteria apply in this reach from October 19 to July 15 each year because of the spawning periods for Mountain Whitefish (October 15 to March 15) and Rainbow Trout (January 15 to July 15). Most of the criteria exceedences occur in October, June and July when the weather is warmer.

The frequency with which the daily maximum water temperature exceeds 13° C seems to increase downstream of Boise, beginning near Eagle Island. However, the large amount of daily data available for the south channel of the Boise River around Eagle Island, compared to other sites in this reach which have bimonthly data, may provide a false impression.

The USGS is currently measuring water temperatures hourly for one full year in the Boise River at Diversion Dam, Glenwood, Middleton, Caldwell and Parma and also in Dixie Drain, Conway Gulch and Willow Creek. When these data are available in the spring of 1998, DEQ will be better able to characterize the extent of salmonid spawning temperature problems in the river.

pH

The USGS measured pH in the Boise River at the same time as DO at the four main river sampling sites. The pH criteria for aquatic life were not exceeded in any of the samples.

Metals

Metals for which data are available are in most cases well below state limits. For certain parameters, such as selenium, the data reported are not directly comparable to the state criteria, but appear to be quite low. In addition, some samples were analyzed with detection limits higher than the state criteria, and thus cannot be evaluated. For example, a value for cadmium reported as less than 1 μg/l on 5/14/92 at Glenwood bridge cannot be compared to the applicable chronic criterion of 0.409 μg/l dissolved cadmium. The concentration in the water may be either less than or greater than the limit.

A few USGS samples from the 1980's have shown exceedences of the aquatic life criteria for mercury and cadmium. However, based on more recent evaluation of sampling and analytical techniques (M. Hardy, USGS, oral commun., 1997), proximity to detection limits and the lack of recent criteria exceedences, DEQ concluded that these data do not indicate mercury or cadmium contamination problems.

Other Causes of Impairment

The components of habitat needed for cold water fish in the lower Boise River include cover elements, gravels for spawning, clean substrate to support insects, and moderate summer water velocities. In the Boise River, most of these habitat elements are absent or are not optimal for a healthy fishery. Only one trout spawning redd has been observed by IDFG, in Logger's Creek. Many of the tributaries that at one time supported trout spawning are now piped beneath the City of Boise. Low winter flows may effectively isolate fish from any remaining spawning habitat in the tributaries.

Flows and Water Velocity

The annual hydrograph of the Boise River, that is, the flow of water in the river over one year, has been significantly altered by flow management for flood control and irrigation. Flows in the Boise River do not reach the peaks that occurred prior to dam construction and flood control. Spring flood flows that used to occur in short peaks are now distributed more evenly across several months, the duration depending on the total water available in the basin and the timing and rate of snowmelt in the spring. Low summer flows characteristic of natural streams have been replaced with higher irrigation flows across the summer. The spring of 1997, a higher than average water year, is an example of a year in which controlled flow prevents flooding, but exposes fish to high velocity water for prolonged periods of time. Low flow conditions occur in the late fall and winter, during spawning periods for Brown Trout and Mountain Whitefish and during the early part of the spawning period for Rainbow Trout.

Velocities in parts of the Boise River between Lucky Peak and Star are often too fast for adult and juvenile trout during the summer months. The velocities observed are high enough to limit trout to the river banks and bottom. Asbridge and Bjorn (1988) found that when flows averaged 4400 cubic feet per second (cfs), high velocity runs are the dominant habitat type in both the Boise River and Loggers Creek.

Minimum Flows and Habitat

In the fall and winter, flows drop far below typical natural flows, stressing fish by limiting their access to cover near banks and tributary spawning grounds. After construction of Lucky Peak Dam, winter time flows in the Boise River occasionally dropped to 80 cfs or less, severely limiting the pools available for fish survival. IDFG holds contracts for 50,000 acre-ft of storage water in Lucky Pear Reservoir. IDFG's storage water, combined with uncontracted storage space held by the U.S. Bureau of Reclamation, provides a minimum flow of 150 cfs during winter low flow periods to provide better winter time support for fish. However, a flow of 240 cfs is more beneficial as a minimum needed to support spawning during the winter months (Jarvis, 1985). The monthly average flow near Boise limits Brown Trout spawning, which occurs primarily in October and November and requires a minimum flow of 225 cfs (Figure 6). Rainbow Trout spawning, requiring a minimum flow of 255 cfs, probably is supported by typical regulated flows, because sufficient average and minimum flows occur in the Rainbow Trout spawning months of April, May and June (Jarvis, 1985). Mountain Whitefish spawning may also be limited by low November and December flows.

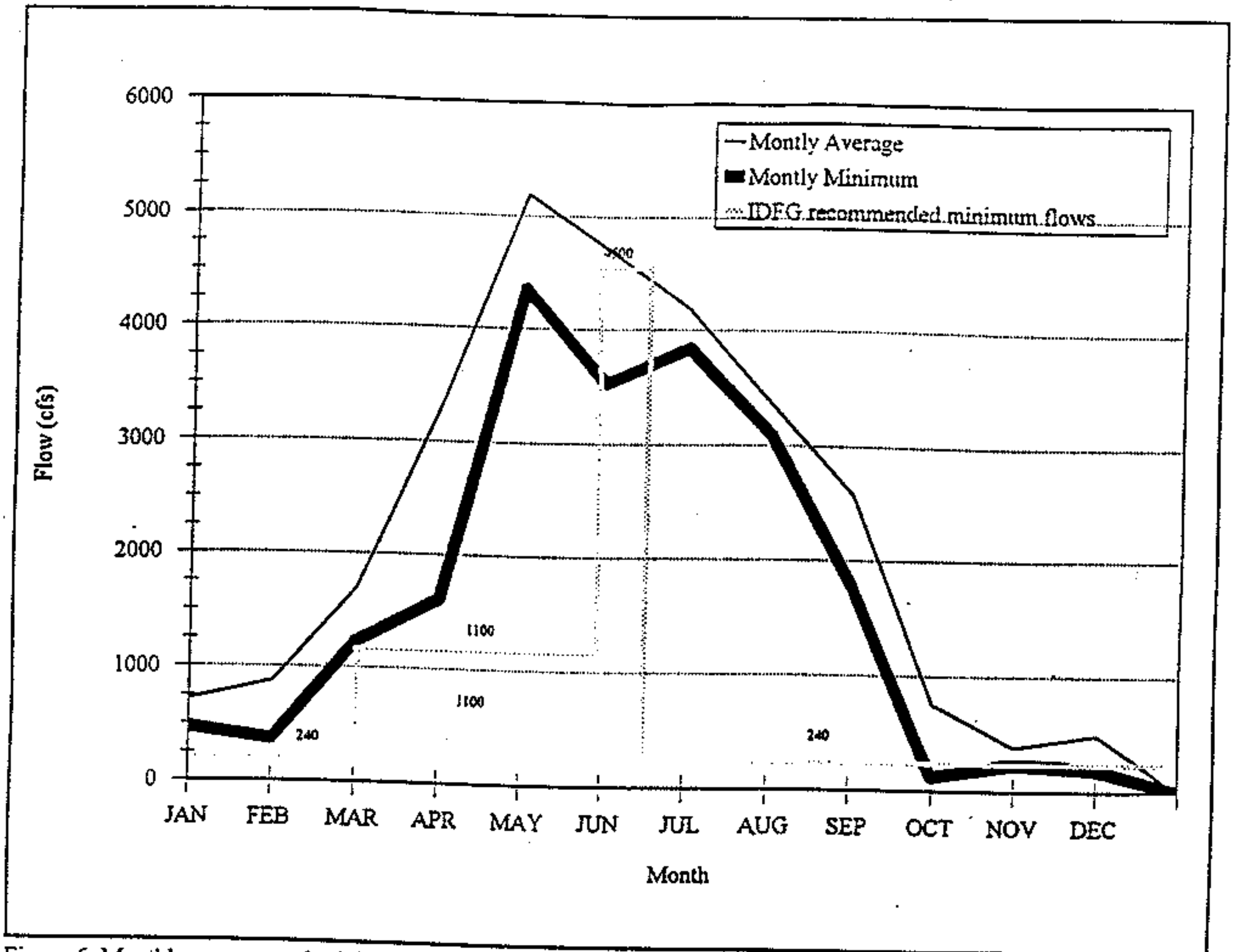

Figure 6. Monthly average and minimum regulated flows in the Boise River at Boise, USGS gaging station 13202000.

The US Fish and Wildlife Service concluded that most of the remaining spawning gravel between Lucky Peak Dam and Star is contained in tributaries, that the gravel is only amenable to spawning when Boise River flows are greater than or equal to 1100 cfs, and is only amenable to rearing at flows greater than or equal to 900 cfs (Pruitt and Nadeau, 1978). The minimum flow requirements for the Boise River are summarized in a letter sent to the Idaho Water Resources Board from Mr. Cal Groen, Natural Resources Policy Bureau Chief at the IDFG (1993). IDFG, based upon the work of Pruitt and Nadeau (1978), suggest a minimum of 240 cfs from June 16th to the last day of February, 1100 cfs from March 1 to May 31, and 4500 cfs from June 1 to June 15.

Status of Aquatic Life Uses

Aquatic life uses are impaired along the entire length of the lower Boise River from Lucky Peak Dam to the mouth of the River. Data on fish populations, aquatic insects and chemical and physical characteristics of the River all indicate impairment. Major causes of impairment include the listed pollutants sediment, temperature. Other causes of impairment include flow management and habitat alteration. A reach by reach summary of the status of aquatic life is shown in Table 7.

Table 5. Status of aquatic life beneficial uses in the lower Boise River by stream segment.

Segment	Designated Uses	Existing Uses	Status	Listed Causes of Impairment	TMDL Required	Other Factors Contributing to Impairment
Boise River, Lucky Peak to Barber Diversion	CWB SS*	CWB SS	Not Full Support	Flow	No	Sediment
Boise River, Barber Diversion to Star	CWB SS	CWB SS	Not Full Support	Sediment	Yes	Flow Habitat Temperature(SS)
Boise River, Star to Notus	CWB SS to Caldwell	CWB SS	Not Full Support	Temperature Sediment	Yes	Flow Habitat
Boise River, Notus to Snake	CWB	CWB WWB SS likely	Not Full Support for CWB, SS	Temperature Sediment	Yes	Flow Habitat

* SS excluded from Lucky Peak Dam to Diversion Dam (IDAPA 16.01.02.140.03).

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